

assessing the impact of effluents from offshore activities by their biological effects – local and regional scales

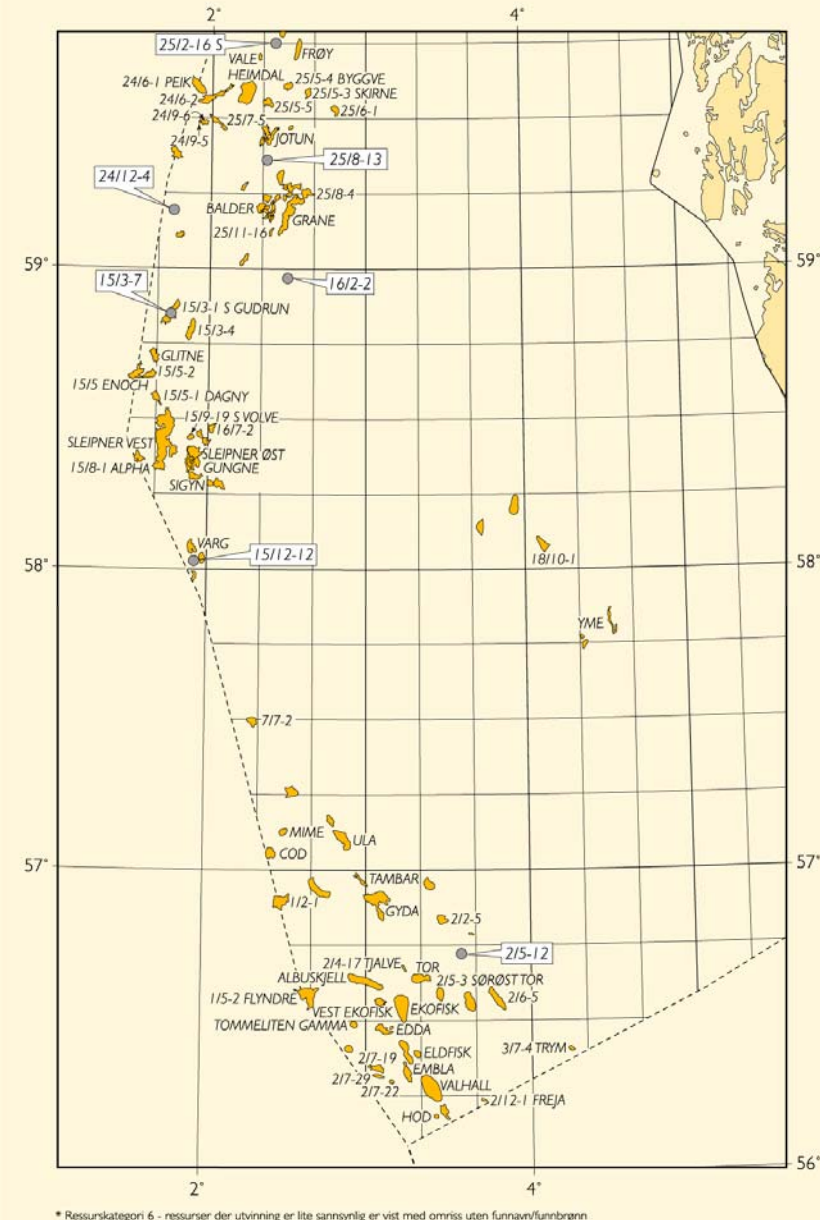
Ketil Hylland (NIVA, Norway)

Steinar Sanni (RF-Akvamiljø, Norway)

Jarle Klungsøyr (IMR, Norway)

the issue

- major inputs of chemicals from offshore activities
 - drilling
 - production
- impacts virtually the entire North Sea to some extent
- ecological impacts not really established
- laboratory data suggest effects, but at levels higher than those generally found
- how can we assess the risk of produced water effluents?



risk assessment

- inputs from many sources need to be considered
 - adjacent production areas
 - drilling in relation to production
 - chemicals change over time
- risk assessment by way of models (DREAM)
 - exposure (3-D model using real-time data)
 - effect (PNECs derived from laboratory tests)
- assessment of biological effects in the field - validation of model or contributions to risk assessment?

effects in the water column

- complementary approaches
 - *in situ* extracts can be tested for mechanisms of toxicity
 - caging provides direct link to local exposure
 - field sampling provides ecological relevance
- which effect methods?
 - identifiable threshold or dose-response level(s)
 - methods should be used in combination
 - quality assurance of methods is essential
- which species/systems?
 - there are no "universal" species, even in a limited area such as the North Sea
 - unresolved problems for the use of fish (migration, exposure)
 - have to be able to separate zooplankton species during sampling

approach	pro's	con's
field sampling	ecological relevance	difficult to assess area integrated (but large); high natural variability (needs large sample numbers)
caging	reflects local exposure (history); can use organisms with desirable properties (e.g. blue mussel and fish)	"semi-natural" exposure situation; food availability unknown; limited to selected species (relevance in relation to local species); exposure at one point (does not integrate over larger area)
<i>in situ</i> extracts/bioassays (can be extended to TIE*)	identify specific mechanisms and substances; sensitive and reproducible; possible to test systems not otherwise included (e.g. early lifes stages in fish)	not possible to extrapolate directly to ecological impact

activities

- WCM 1999-2000
 - caging (passive samplers, blue mussels)
- DREAM development
- BECPELAG
 - field-collection
 - caging
 - extracts
 - modelling
- WCM 2003
 - caging (cod, blue mussels)
 - few locations
- regional monitoring 2002-2003
 - field-collection
 - haddock, saithe, cod, pelagic species
 - a range of endpoints

activities

- WCM 1999-2000
 - caging (passive samplers, blue mussels)
- DREAM development
- BECPELAG
 - field-collection, caging, extracts, modelling
 - many methods
- WCM 2003
 - caging (cod, blue mussels)
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 - histopathology and biomarkers
- regional monitoring 2002-2003
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indications that there may be effects - BECPELAG

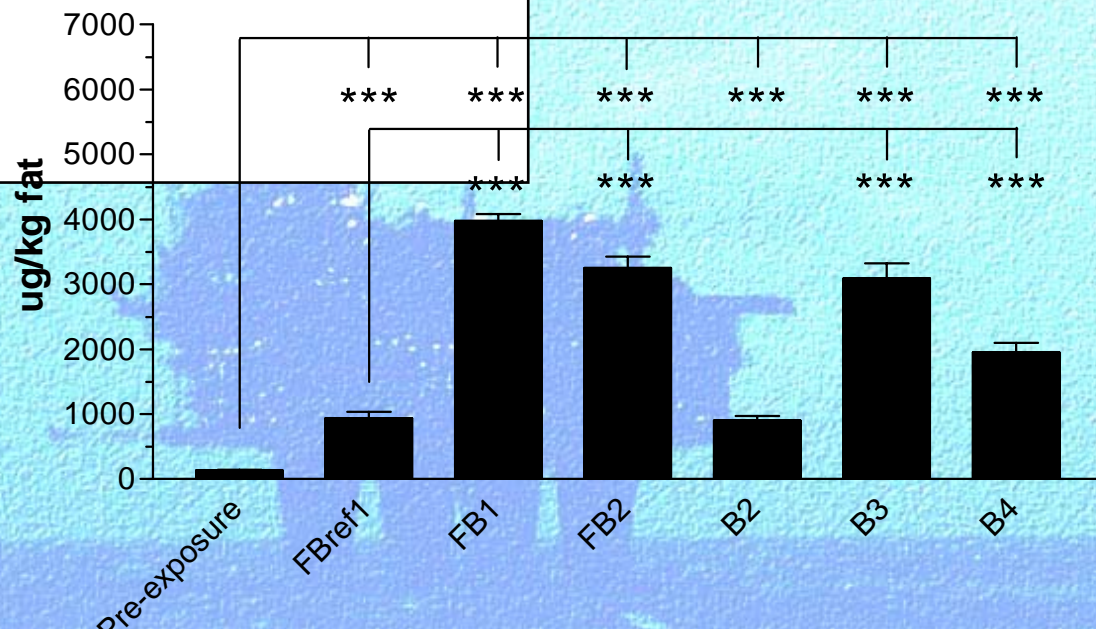
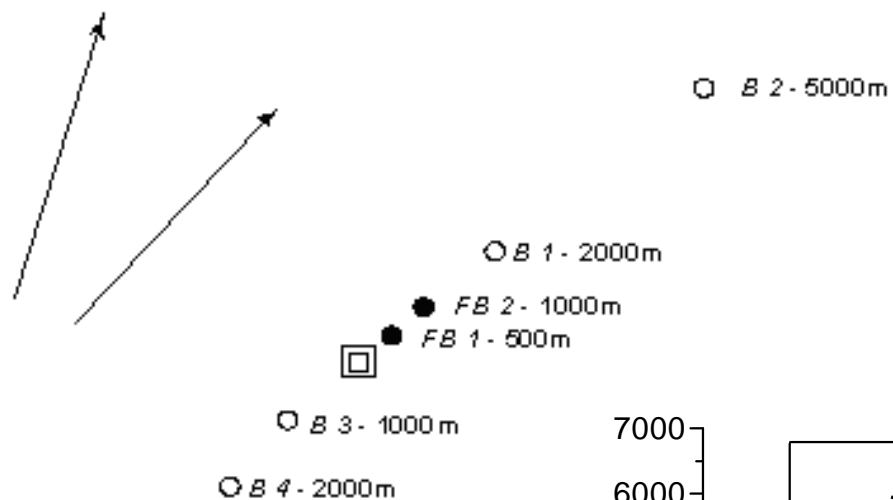
- gradient for PAH exposure away from platforms – predominantly 2-/3-ring
- clear responses in caged blue mussels
- histopathological changes in both caged and field-collected fish; no obvious effects for biomarkers
- more responses in caged organisms (cod, blue mussel) than in field-collected organisms
- limited responses in bioassays of SPMD extracts

the follow-up: WCM 2003

- Troll field
- caged blue mussels, cod
- blue mussels
 - PAH
 - histopathology
 - BaPH
 - lysosomal stability (on board)
- cod
 - PAH-metabolites
 - histopathology
 - vtg
 - EROD
 - GST

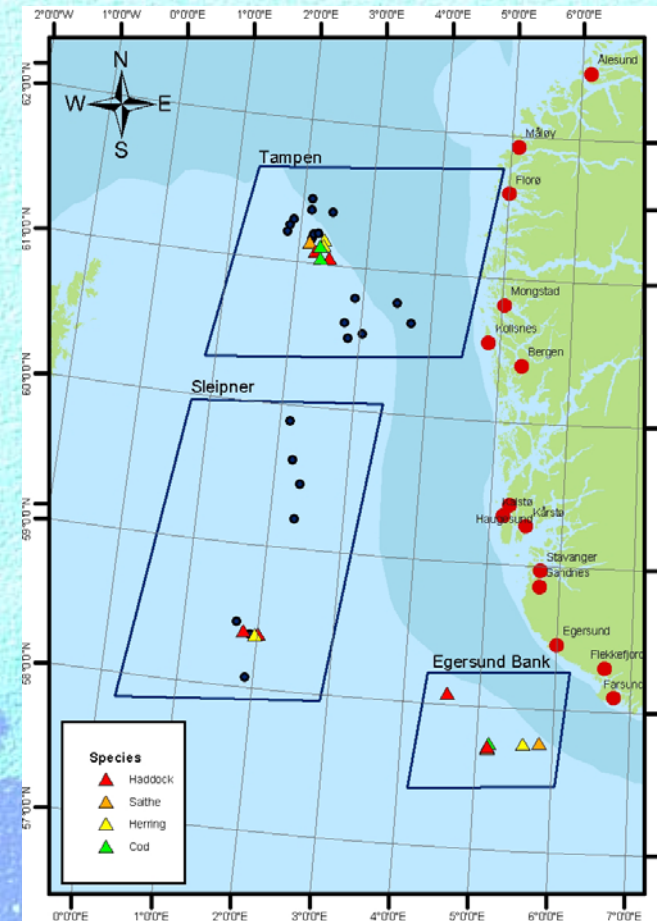
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- Troll B
- blue mussel
- cod & blue mussel



regional studies: what is this?

- different fish species sampled in three areas:
 - Tampen (high input)
 - Sleipner (low input)
 - Egersund banken (reference)
- haddock, saithe, cod, herring, ++
- endpoints included
 - alkylphenols and PAHs in muscle and liver
 - PAH metabolites in bile
 - a range of biomarkers including phase-I, phase-II enzymes, antioxidant enzymes and DNA adducts
 - lipid composition of muscle
- results indicated
 - differences between areas with regard to:
 - some PAH metabolites
 - phase-I enzymes, antioxidant responses
 - lipid composition
 - DNA adducts



risk assessment?

- risk assessment models predict effects near platforms, but not in larger areas
- have we detected all ecologically relevant impacts?
- which options are available?
 - revise model with new data
 - combined modelling and field measurements
 - rely more heavily on field measurements (needs larger resources)

summary and the future

- risk assessment models are probably not sufficiently predictive of environmental impacts from produced water inputs
- it is difficult to separate impacts from specific activities (drilling, production) or effluents from different production areas
- a link should be established between the risk assessment models and field data ("validation")
- a large-scale "inventory" of possible effects in the North Sea from offshore activities is needed (research on ecologically relevant endpoints)

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